Rail

Ray King

'Smooth Operator' elsewhere in this issue employs model control servos to drive the turnouts on a model railway. One of its advantages is that it can be activated over a single wire making it ideal for computer control described... here! Rail Router is a hardware/software combination capable of controlling up to 127 turnouts.

Router

model train routing with a PC

The Rail Router hardware comes in two flavours: a **master** router board capable of directly controlling up to 15 devices and a **slave** board connected up via a ribbon cable and adding a further 16 turnout controls. The general layout of the system is illustrated in **Figure 1**. The master and slave circuits use the same printed circuit board stuffed to reflect the desired function. Slave routers are optional — if you are satisfied with 'just' 15 turnouts and/or semaphores then you're fine with just the master router.

A dual-purpose circuit...

The circuit diagram shown in **Figure 2** is unusual in that it shows the master as well as the slave circuit. Dashed outlines and connections are used to indicate the difference between the two circuits, which can be built on one and the same board. Electrically the difference between the two circuits exists in the presence or absence of jumpers and circuit parts. The MAX232 two-way RS232/TTL level converter, for example, is only required for the master function, which (as you may have guessed already) requires a connection with a PC running the specially written Rail Router control software (more about this further on). The RS232 port on the PC is connected up to the Rail Router master board via sub-D socket K17. Only Tx/Rx traffic is used, without handshaking.

A PIC16F877 microcontroller is found at the heart of the master as well as the slave circuit. Although the micro is loaded with the one that the same software for the master or slave function, it actually selects between two different code chunks by looking at the logic level you've defined at port line RC5 by means of jumper JP1. The 16F877 ticks at 8 MHz as determined by quartz crystal X1 and its loading capacitors C1 and C2.

The master and slave router boards require a power supply of 8 V to 15 V DC which can be provided by a small mains adaptor or from a DC outlet on one of the railway speed governors.

Master operation

The PIC micro continuously monitors the incoming serial information, determining whether the device specified in the command is comprised in the first 15 turnouts. If so, it changes the state of the turnout control (via K2-K16). If not, it passes the information over to buffer IC3 and from there to connector K18 for slave units to test. Each output connector (K1-K16) on the router board comprises an unregulated supply (V+) ground and the control lead as required by the 'Smooth Operator' servo control circuits. Note that Output #1 (K1) is not used by the master configuration. It is planned to employ it at a later stage for enhanced facilities.

Slave operation

The operation of the slave board is similar to that of the master but simpler because of the absence of the RX/TX serial interface with the PC. The unique address of each slave board is determined by the settings of DIP switch S1. Setting the address to 001, for example, allows the slave board to operate turnouts 16 through 31, where code 001 is RE2 = 0; RE1 = 0 and RE0 = 1 on the PIC.

... and a dual-purpose circuit board

As already suggested by the circuit diagram, the circuit board designed for the Rail Router system can act as a master or a slave, depending on how it is populated. The two different component stuffing plans are given in **Figures 3a** (Master) and **3b** (Slave). Carefully study the parts list and the component overlays to avoid hard to find problems. If necessary, refer back to the circuit diagram. All components on the two boards are regular-size devices and construction is therefore not expected to cause any difficulty if you take your time and pay attention to polarised components in particular (ICs, transistors, electrolytic caps). We recommend using a good quality socket for the PIC device(s) as it (they) will the most expensive part(s) in the circuit.

The PIC software

We can be very brief about the software run by the PIC micro(s) used in this project. Do-it-yourself programmers among you will be pleased to know that the complete annotated source code files supplied by Ray King are available free of charge from our website under ref. **030403-11**. Simply download them, compile and then program your own 16F877 chip. Alternatively use the hex code directly.

Those of you without the means or wherewithal to burn your own PIC chip may resort to our Readers Services who supply ready-programmed PIC chips for this project under order code **030403-41**.

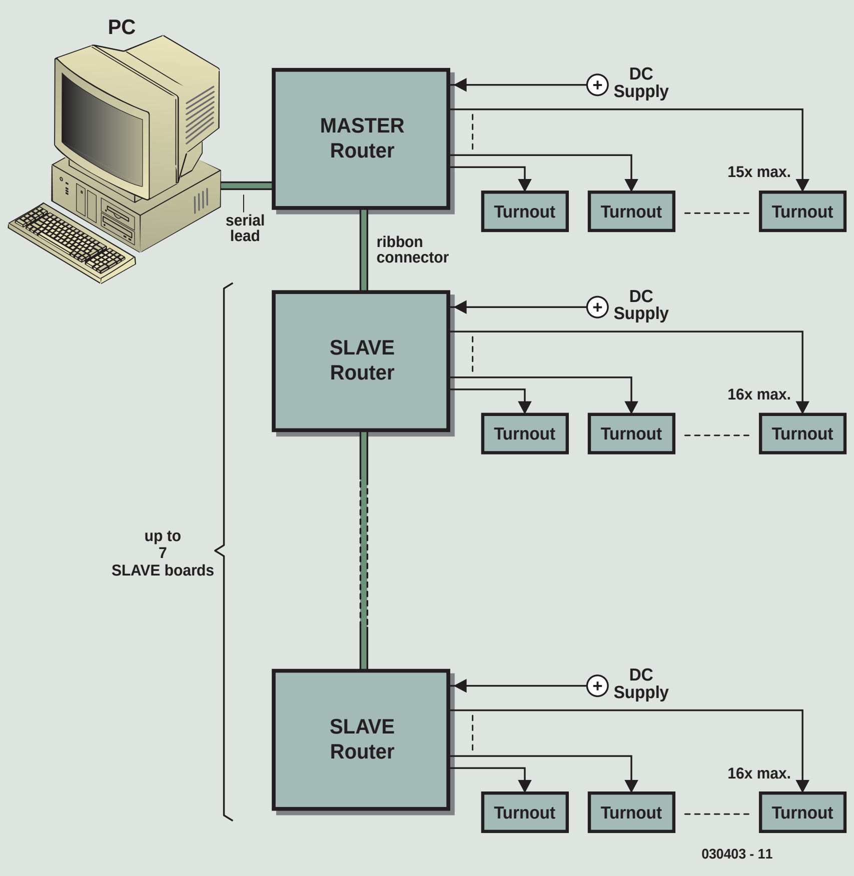


Figure 1. A complete system would be set up like this. The boxes marked 'turnout' represent a 'Smooth Operator' unit.

Rail Router for the PC

A screenshot of the Rail Router software running on a PC is shown in **Figure 4**. Any number of track layout designs may be stored on the PC and loaded when the Rail Router program is launched, or at any time during a session. The software written by Ray offers the facility to design and alter the railway layouts before saving them to disk. The baud rate to the master router is 9600 bits/s. The PC software was written in Visual Basic 6 (VB6). The source code (.VBP and components) as well as the executable version are included in the 'software package' for the project, ref. **030403-11**.
Simply run the railrout.exe file and the program will be installed on your computer.
The latest updates and hardware additions may be found at Ray King's website.

Design a track layout...

Click on the 'Change Layout Design' button and the design screen will appear. Click on any square in the layout area, then click on the required symbol to be put in this square. Continue adding symbols until your layout is complete. Make sure all sidings as well as roads in and out of the layout end

COMPONENTS LISTS

Master Router

Resistors:
R1 = 4kΩ7
R2,R3,R4 = 10kΩ
R5 = 47kΩ

Capacitors:
C1,C2 = 22pF
C3-C7,C9 = 10µF 25V radial
C8,C11,C12 = 100nF
C10 = 1µF 16V radial

Semiconductors:
IC1 = PIC16F877-20/P, programmed, order code **030403-41**
IC2 = MAX232
IC3* = 74HCT241
IC4 = 7805

Miscellaneous:
JP1,JP2 = jumper
K2-K16 = 3-way SIL pinheader
K17 = 9-way sub-D socket (female) angled pins, PCB mount
K18* = 10-way boxheader
K19 = 2-way PCB terminal block, lead pitch 5mm
X1 = 8MHz quartz crystal
PCB, order code **030403-1** (see Readers Services page)
Disk, all project software (PIC & PC), order code **030403-11** or Free Download

* only required when a Slave Router is connected

Slave Router

Resistors:
R2,R3 = 10kΩ
R5-R8 = 47kΩ

Capacitors:
C1,C2 = 22pF
C9 = 10µF 25V radial
C12 = 100nF
C10 = 1µF 16V radial

Semiconductors:
T1 = BC550
IC1 = PIC16F877-20/P, programmed, order code **030403-41**
IC4 = 7805

Miscellaneous:
K1-K16 = 3-way SIL pinheader
K18 = 10-way boxheader
K19 = 2-way PCB terminal block, lead pitch 5mm
S1 = 3- or 4-way DIP switch
X1 = 8MHz quartz crystal
PCB, order code **030403-1** (see Readers Services page)

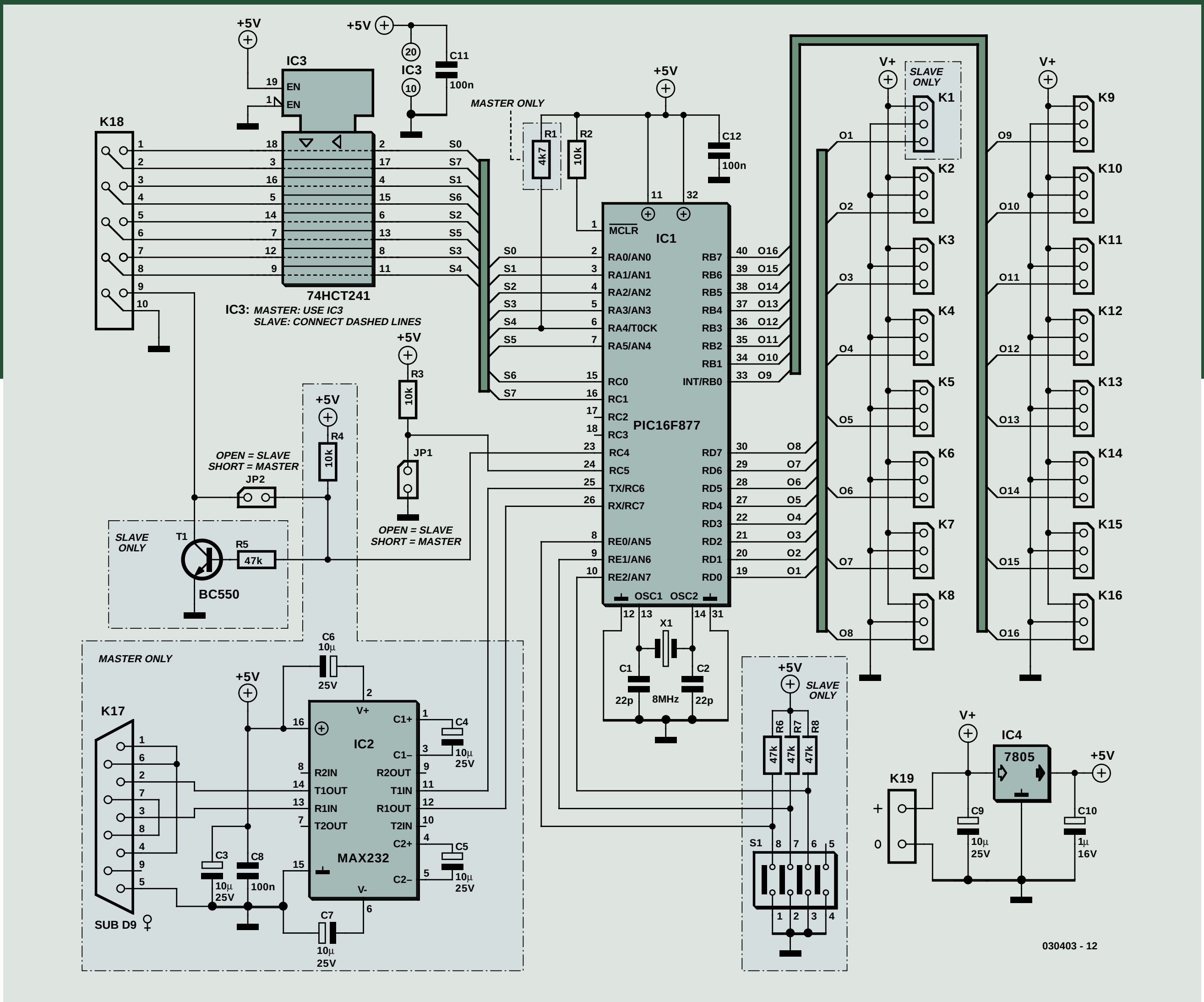


Figure 2. Combined circuit diagram for the Master and Slave Router configurations.

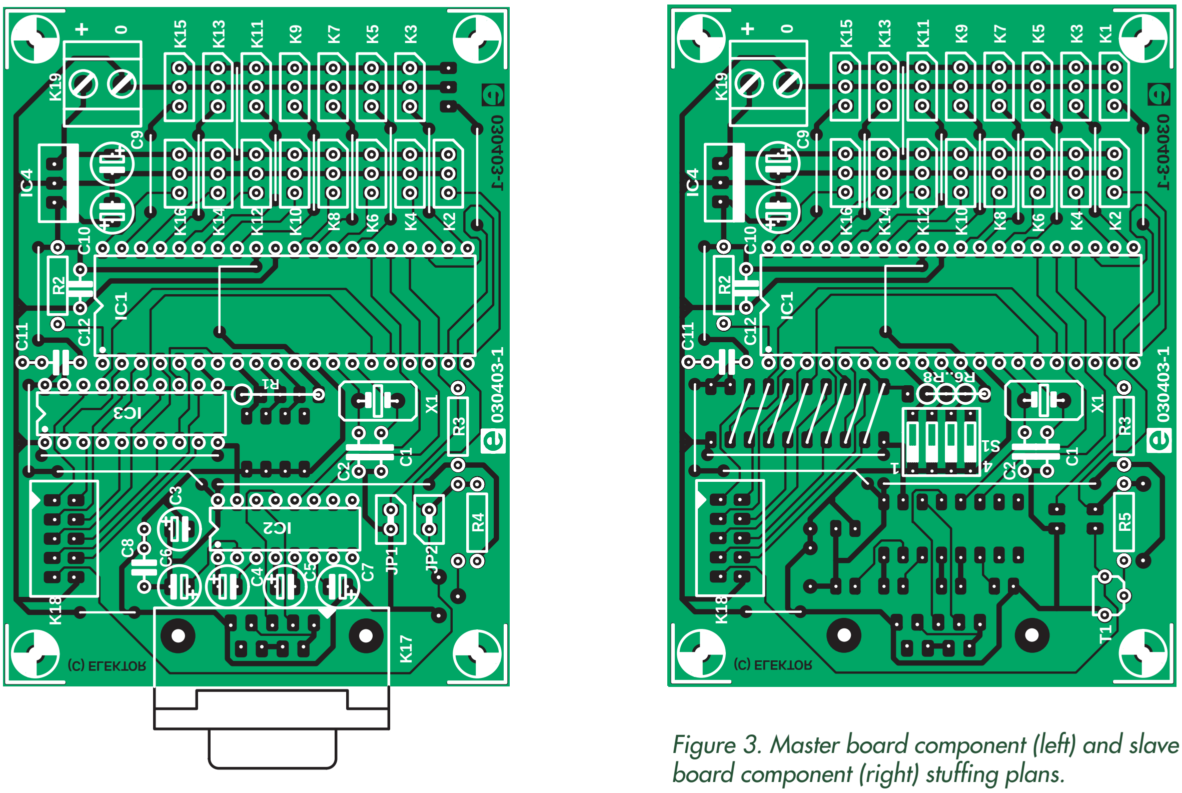
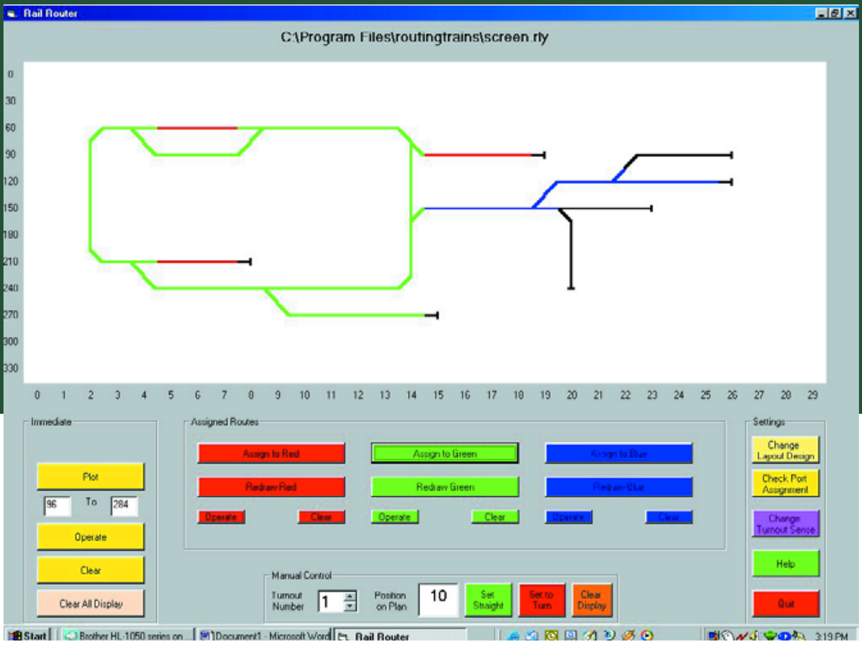


Figure 3. Master board component (left) and slave board component (right) stuffing plans.


Rail Router

C:\Program Files\routingtrains\screen.rly

96 To 284

Turnout Number 1

Position on Plan 10

Figure 4. The Rail Router PC software in action.

Free Downloads

PC and microcontroller software. File number: 030403-11.zip

PCB layout in PDF format. File number: 030403-1.zip

www.elektor-electronics.co.uk/dl/dl.htm, select month of publication.

with an ‘end’ symbol. When done, click on ‘Save Design and Exit’ and give the layout a name when prompted.

When the layout is saved, the program records details of all turnouts and allocates a hardware ‘port’ to each one. To check the assignments, click on ‘Check Port Assignment’ to produce a list of the turnout number from the diagram and its associated hardware port. This hardware port (i.e., K2-K16 on a master board, or K1-K16 on a slave board) should be wired to the ‘Smooth Operator’ control for that particular turnout.

On installation it is possible that the turnout mechanism works in the opposite sense to the software, that is, if ‘ahead’ is selected the turnout moves to the turn. This can be resolved by using the ‘Change Turnout Sense’ button. This option will ask for a port number and will invert the sense (digital polarity) of the port. This information is displayed on the port assignment screen.

… change it…

Click on the ‘Change Layout Design’ and the current layout will be displayed. You can add or delete symbols to change the layout as necessary. Next, save the modified design by clicking on the ‘Save and Exit Design’ button. Alternatively you can abandon the changes by clicking on ‘Exit Design without Saving’. There is also an option to load another layout, enabling the same software to be used for a number of different layouts.

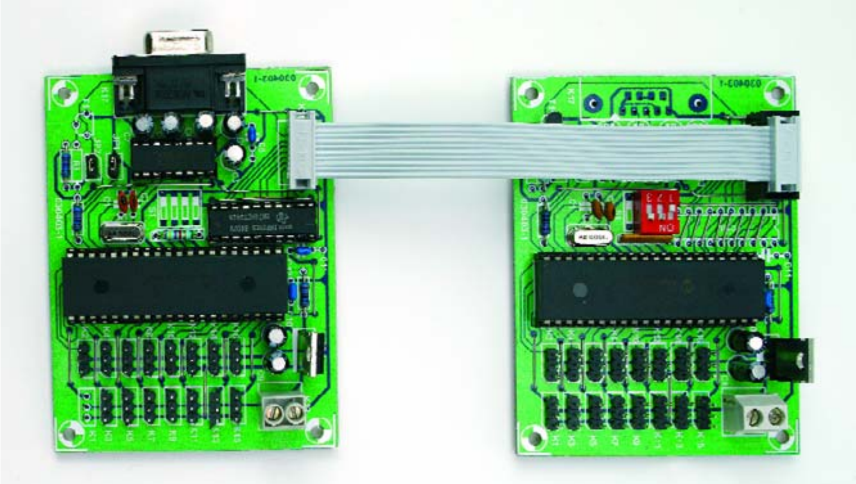


Figure 5. Master Router coupled to a Slave Router by a piece of flatcable.

… and be a train controller

Click on the section of track which you intend the route to start on and then click on the track section where you want to finish. Click on ‘Plot’ and the program will attempt to find a path from start to finish. If it succeeds, the route will be highlighted in yellow. If not, ‘No Route Found’ will be visible. If the routing is successful but you feel there is a better way through then simply click on ‘Plot’ again until your preferred route is selected.

The yellow route can be operated directly using the appropriate button, alternatively it can be stored against one of the three coloured routes and operated at any time. Up to three different routes can be stored in this way.

Avoid starting or ending your route from a crossover, turnout or end sign as these can cause the software to produce unusual results — normally false ‘No Route’ messages, which, come to think of it, is not as bad as ‘No Train Services Today’.

(030309-1)

Web pointer

www.king.ray.btinternet.co.uk/index.htm

Location photograph courtesy South Limburg Steam Railway Foundation (www.zlsm.nl)